TEXTILE RESEARCH

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TEXTILE RESEARCH

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VOL. XIII **TEXTILE RESEARCH** NO. 1

Outstanding Features in

This Month's Issue

Research in the South

F. S. Blanchard reports his southern trip during which he visited 40 mills. He found greatly stimulated interest in research with a number of mills equipping research laboratories. (See page 2.)

A Cotton Slasher Blanket

A cotton blanket for covering the squeeze rolls on a slasher has been developed and is under test. The results show definite possibilities due to low cost and extremely long life. (See page 4.)

Measuring Fiber Fineness

A new method for measuring fiber fineness has been developed at the Texas Agricultural Experiment Station. The principle of surface per gram is used, but comparisons are made between the fineness as measured by the pressure difference and in weight-per-inch. (See page 12.)

Chemically Modified Wool of Enhanced Stability

Wool that moths cannot digest and that is several times as resistant to alkali with no impairment of its softness or strength is now possible through a new process yielding chemically modified wools of enhanced stability. (See page 21.)

Visit to Many Mills Shows Growing Interest and Expanding Facilities for

Research in the South

By FESSENDEN S. BLANCHARD

OUR MEMBERS may be glad to learn of some of the research developments and interests which I found on a recent trip through the South in which I talked with executives and research men in over forty southern mills.

Among the principal purposes of my trip were: (1) to size up the interest in research or lack of it (and the reasons), among different men and types of mills; (2) to develop closer personal relations among both members and non-members and to endeavor to understand their problems better; (3) to stimulate interest in research and a better understanding of our own organization and its present close cooperative arrangement with the Textile Foundation; (4) to make contacts with other research organizations to aid in bringing about closer cooperation and the avoidance of duplication of work.

I found southern mills as hospitable to ideas as they are to people and a growing interest in the value of research, evidenced partly by the number of mills who were setting up laboratories and looking for research men, also by the attitude towards research which southern mill executives expressed. Special research interests varied from fundamental to very "practical" and included some of the following subjects of which the first two listed were most frequently mentioned:

(1) Fundamental research on cotton fibers aiming towards chemically improving the fiber, such as by increasing strength, friction between fibers, etc.,—in order to make stronger yarn or to enable equally strong yarn to

be made with shorter cotton, or to give cotton other qualities (such as greater resilience, etc.,) to enable it to compete better with other fibers or synthetic products.

(2) Studies to determine what happens to the fiber at each process, aided by photo-micrography, for the purpose of improving the running of the work, lowering costs, and aiding in labor satisfaction and productivity.

(3) Improved handling of high density cotton.

(4) Improved cleaning of cotton at the gin to aid opening processes.

(5) Relative spinning value of cotton.

(6) How to treat cotton chemically to dispose of foreign matter and eliminate the cleaning processes.

(7) Reducing the stretch of cotton cord to replace sisal or jute for tent cords or mail packaging.

(8) Substitution of lighter weight yarns or fabrics for military purposes, without loss of strength.

(9) Stronger cotton tire cord.

(10) Warp sizing of cottons and rayons.

(11) Water repellency of military fabrics. (Note: Our Information Service will shortly bring out a special supplement to "Textile Research" on this.)

(12) Flame-proofing of military fabrics. (We are planning this as a subject of another special supplement.)

(13) Research on the acid resistance of fabrics and the effect of acid on strength.

(14) Can we change the relative proportion of the amorphous and crystalline materials in cellulose?

(15) More about the effect of oxidizing agents on waxes, pectins, etc.—supplementing existing information on bleaching effect of oxidizing agents on cellulose.

(16) Effect of infra red on strength of yarn.

With the evident belief in the vital place of research in the war and postwar economics and the splendid start already made by certain outstanding mills, textile research is well on its way from its present position near the bottom of the research ladder (measured by men and money engaged) to the position where it belongs.

Initial Tests Indicate Possibility of the Successful Development of

A Cotton Slasher Blanket

By G. H. DUNLAP*

This preliminary report on a cotton blanket for covering the squeeze rolls on the slasher gives the result of several months experimentation in which four leading cotton weaving mills in the Southeast cooperated with the Southern Textile Association, the Arkwrights, and the Textile Foundation.

LACK OF RESILIENCE and the hardening of the cotton blanket on the rolls have been the chief objections to the use of a blanket made from cotton. This hardening of the cotton blanket has a tendency to flatten the yarn, and does not allow the proper penetration of the size solution into the yarn during slashing.

The principal reasons given for slashing cotton warp yarns are: (1) to improve the weaving qualities of the yarn, (2) to give added weight to the finished fabric, and (3) to produce a given finish to the woven cloth. The squeeze rolls on a slasher, weighing several hundred pounds, have to be wrapped with a fabric that possesses a cushion, and wool because of its resiliency has served the purpose for many years despite the many attempts to substitute other fibrous materials.

In developing the cotton blanket material used in these tests, consideration was given to past criticism of

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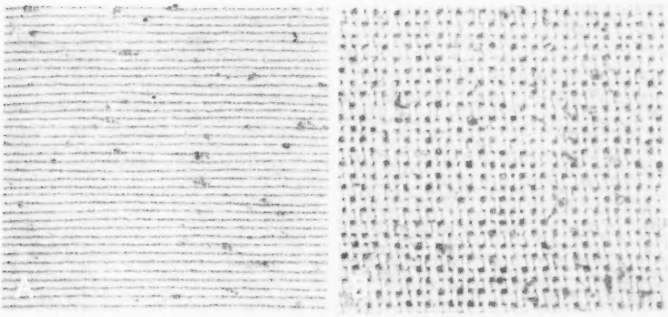
the cotton materials. The construction of the fabric used in the cotton blankets in these tests is given as follows: (a) width in inches—60, (b) ends per inch—72, (c) picks per inch—19, (d) warp count—30s, (e) filling count—1.5s (Produced on Speeder), and (f) yards per pound—.61.



Two types of cotton slasher blanket. A—Blanket used in the tests described. B—Blanket to be tested.

It is not asserted by any of the cooperating mills that the cotton slasher blanket possesses the cushioning properties of wool. It is admitted that the cotton blanket will harden on the squeeze rolls with use. However, this condition can be easily remedied by frequent washings of the blankets in water. The cooperating mills also state that the blankets should be removed from the rolls and left in water when the practice of stopping the slasher over the weekends is followed.

Low Initial Cost and Long Life

The low initial cost and long life are the main advantages claimed for the cotton blanket. It is recognized that this cotton fabric may not be suitable as a slasher blanket for the slashing of all types of weaving yarns, but on certain constructions, such as have been selected for these tests, it has proved successful. In only one of the four cooperating mills has the life of

TABLE I. A Cotton Slasher Blanket—Mechanical Information, and Construction of Cloth Woven

Mechanical Information

Cooperating Mill	A		B		C		D	
Type Blanket	Wool	Cotton	Wool	Cotton	Wool	Cotton	Wool	Cotton
Count of yarn slashed	36/2s	36/2s	36/2s	36/2s	29.65	29.65	30.00	30.00
Yards slashed per minute	36	36	25	25	36	36	60.5	60.5
Weight of first squeeze roll	———	———	500	500	360	360	245	245
Weight of second squeeze roll	———	———	400	400	550	550	468	468
Temperature of:								
Small cylinder (degrees F)	232	232	230	230	*	*	220	220
Large cylinder (degrees F)	241	241	230	230	*	*	210	210
Size box (degrees F)	202	202	200	200	———	———	204	204
Temperature controls: Cylinders	yes	yes	yes	yes	no	no	yes	yes
Size box	yes	yes	yes	yes	no	no	yes	yes
Level control in size box	yes	yes	yes	yes	no	no	yes	yes
Yards of blanket on: First squeeze roll	7	5	8	5	5	5	7	5
Second squeeze roll	7	10	8	10	6	10	7	10

Construction of Cloth Woven by Cooperating Mills

Ends per inch	105	105	101	101	64	64	22	22
Picks per inch	56	56	54	54	60	60	18	18
Width of cloth (inches)	40	40	44.47	44.47	41	41	37.5	37.5
Yards per pound	1.72	1.72	1.50	1.50	5.00	5.00	19.0	19.0
Type goods	Army twill	Army twill	Army poplin	Army poplin	Shade cloth	Shade cloth	Gauze	Gauze

TABLE II

A Cotton Slasher Blanket. Comparative Test Results of Cotton Yards Slashed with the Squeeze Rolls Covered with Wool and with Cotton Blankets

Tabulation of Results

Cooperating Mill	A		B		C		D	
Type Blanket	Wool	Cotton	Wool	Cotton	Wool	Cotton	Wool	Cotton
Loom stoppage per hour or per cent production	93.00	93.00	94.00	94.00	.55	.52		
Per cent size in yarn	3.98	3.57	5.08	4.50	12.50	11.20	8.18	7.94
Per cent moisture in sized yarn	3.84	4.87	6.12	5.92	8.23	7.51	7.75	8.09
Per cent regain in sized yarn	3.99	5.12	6.52	6.29	8.97	8.12	8.41	8.80
Per cent stretch in:								
Sized yarn	4.25	5.13	4.62	5.60	4.78	5.00	5.83	5.76
Unsized yarn	6.26	6.26	8.58	8.58	5.52	5.52	6.68	6.68
Single strand tensile strength:								
Sized yarn (pounds)	1.31	1.30	1.36	1.33	.752	.749	.635	.652
Unsized yarn (pounds)	1.24	1.24	1.29	1.29	.590	.590	.571	.571
Increase in tensile strength of sized yarn over unsized yarn (per cent)	5.65	4.84	5.43	3.10	27.46	26.95	11.21	14.19
Decrease in stretch after sizing (per cent)	32.11	18.05	46.15	34.73	13.41	9.42	12.72	13.77
Life of blanket (hours)	336	[1]	500	[2]	288	1608	336	[3]

* 9 pounds steam pressure. [1] Running since Aug. 24. [2] Running since Aug. 26. [3] Running since Sept. 4.

the cotton blanket been determined. Test data for this mill show that the cotton blanket ran for a period of 1608 hours, as compared with 288 hours for the wool blanket. The other mills are still running the test and as yet have encountered no difficulty. The cost of the cotton blanket material is estimated to be about one-fifth the initial cost of wool.

The count of yarn slashed, the yards slashed per minute, the weight of squeeze rolls and the other mechanical conditions observed during the testing of the cotton blankets is shown in Table I.

Results Tabulated in Table II

Attention is called to the fact that in each of the cooperating mills where the yarns were slashed with the squeeze rolls covered with the wool, and with the cotton blankets, samples of the sized and unsized yarns collected for test purposes were taken from the same set of warper beams. In each mill the same slasher was employed for testing both the cotton and wool squeeze roll coverings. These results have been tabulated and are shown in Table I and Table II.

All of the physical testing was done by G. H. Dunlap in the laboratories of the Cotton Branch of the Agricultural Marketing Administration, United States Department of Agriculture, located in the Clemson Textile School, Clemson, South Carolina.

The cotton slasher blanket was developed and manufactured by the Joanna Textile Mills Company, Goldville, South Carolina. This cotton manufacturer cooperated in the test by supplying a sufficient quantity of the material for testing purposes in all of the mills listed in this report.

These data represent the results from tests made in four mills and are not intended to show that the cotton slasher blanket, of the construction used in these tests, is satisfactory for slashing all counts of weaving yarns for all constructions of fabrics.

RESEARCH ACTIVITIES

The second supplement to *Textile Research* is now being issued by the Textile Research Institute. The subject is "Waterproof and Water-Repellent Fabrics." The text deals with a general discussion of materials for rendering textiles resistant to water and the methods for treating fabrics. A comprehensive bibliography of approximately 100 references covering the more important material dealing with the subject is included. Copies of this report may be obtained by writing the editorial office of Textile Research Institute, 10 East 40th St., New York, N. Y.

Dr. Milton Harris, director of research of the Textile Foundation and Textile Research Institute, was honored at a dinner held in his honor at Waynesboro, Va. recently by the Virginia section of the American Chemical Society. Dr. Harris spoke on the subject, "Recent Developments in Textile Fibers."

Development of the use of rayon for a packing material as a substitute for the rope packing previously made from flax is announced by Du Pont. Rayon tow is being used in the braided rope and it is said that the smooth, unbroken filaments of rayon show a very low abrasion to the machine shaft.

Rarely has an address received greater publicity than has been given to extracts from the recent address of Dr. Charles M. A. Stine, president of the du Pont Company. The complete address, entitled, "Moulders of a Better Destiny," may be had in pamphlet form by writing E. I. du Pont De Nemours

& Company (Inc.), Wilmington, Del. This little booklet should be read by every American. Dr. Stine's remarks will not only inspire pride in the accomplishments made possible by research in the past two decades, but they hold out such promise for a better future that it should inspire everyone to go the limit in our fight to preserve "the freedom to mold a better destiny, both for the individual and for the race."

Among the outstanding features of the National Chemical Exposition to be held this year November 24 to 29 in the Hotel Sherman at Chicago, will be the first symposium of electron microscopists. The symposium is designed to bring all concerned up to date on technique in the use of the microscope and lead to more efficient use of the few machines now in existence said to be about 40 machines. Another important place will be given to a program intended to further the campaign of the WPB in its plan to salvage 100 million pounds of essential chemicals.

All price controls on sales of commodities and services rendered under the office of Scientific Research and Development contracts and "secret" sub contracts have been removed by the OPA.

A new textile finishing agent, "Avitone" A, derived from petroleum, has been announced by Du Pont. It is said that "Avitone" A will give the same effect as sulfonated tallow and will release large quantities of tallow which is needed for military purposes. Tallow is used in processes for glycerin recovery. The cost of "Avitone" A is said to compare favorably with the sulfonated tallow on which orthodox finishes are based.

RESEARCH ACTIVITIES

The New York Section of the American Association of Textile Chemists and Colorists have scheduled several meetings for this season. The next meeting to be held December 4, will probably be at Downtown Athletic Club, New York, and deal with the dyeing and finishing of woolens for navy requirements. Definite announcement will be made shortly.

Cotton research was discussed at the afternoon session of the annual meeting of the Cotton-Textile Institute, Inc., held October 22 in New York. Perrin N. Collier, vice-president and director of research, Callaway Mills, outlined the competitive position of cotton in the future postwar period and recommended some of the research needed if cotton is to maintain its position. Dr. Simon Williams, research technologist, University of Texas, described ways and means for immediate and future action and told of the activities at the research laboratory at the University of Texas. Dr. D. F. J. Lynch, director, Southern Regional Laboratory, New Orleans described the laboratory and the type of work in which it is engaged. Fessenden S. Blanchard, president of the Textile Research Institute presided.

Dr. Harrison E. Howe, editor of Industrial and Engineering Chemistry, has been awarded the medal of the Society of Chemical Industry for 1942. This medal is awarded annually to "a person making a valuable application of chemical research to industry." The award was presented at a joint meeting of the American Section of the Society of Chemical Industry and the New York Section of the American Chemical Society in New York on November sixth.

Saving in Time and Lower Operating Costs Offered by New Precise Method of

Measuring Fiber Fineness

By MARY ANNA GRIMES*

FINENESS IS ONE OF THE MOST IMPORTANT properties of the cotton fiber, but, unfortunately, its determination is difficult and time-consuming by any of the methods usually employed. The methods ordinarily used include determination of the cross sectional area, ribbon width or weight-per-unit-length. Of these the weight-per-inch is probably the quickest and most used method.

A newer and much more rapid method, making use of the air permeability of a mass of the fibers, has been suggested and techniques have been reported by Sullivan and Hertel (1). By this method the surface per gram is used as the final measurement. It is calculated after determining the pressure difference produced in a kerosene manometer by air passing through the cotton. Comparisons are then made with the areas of cross sections. The same principle has been used in the method described in this paper, but comparisons are made between the fineness as measured by pressure difference and in weight-per-inch of the same cottons.

Preliminary work indicates that the method proposed can be used satisfactorily for measuring the fineness of wool and mohair fibers and probably of other textile fibers.

* Textile and Clothing Specialist, Texas Agricultural Experiment Station, Agricultural and Mechanical College, College Station, Texas. FINENESS OF FIBERS AS MEASURED BY AIR PERMEABILITY AND WEIGHT PER INCH. Approved for publication by the Director of the Station as Technical Contribution No. 754.

The apparatus was constructed with certain modifications from the description given by Sullivan and Hertel (1). The apparatus is shown in the accompanying sketch. It is composed of a 2000 ml. flask, glass tubing, and stop-cock, a measuring micrometer and microscope, specimen holder, mineral oil, and kerosene. The flask is embedded in plaster of paris poured into a zinc collar. To the bottom of the flask is joined a glass tube fitted with a stop-cock. A tube forming a manometer is joined to the neck of the flask. The manometer is attached by rubber tubing to the specimen holder. The plunger within the cylinder holding the fibers is so designed that any length of wad up to 9 cm. can be used. In this experiment 250 mg. of cotton were compressed in a space 1.8 cm. in diameter and 2 cm. long. The end of the plunger pressing on the cotton is well perforated with small holes as is also the metal against which the other end of the cotton is pressed, thus permitting free movement of air through the fibers. With the wad of fibers in place, the stop-cock is turned to permit the mineral oil to flow from the flask at a constant rate. As the oil flows from the flask, it is replaced by air which must enter through the wad of fibers. This movement pro-

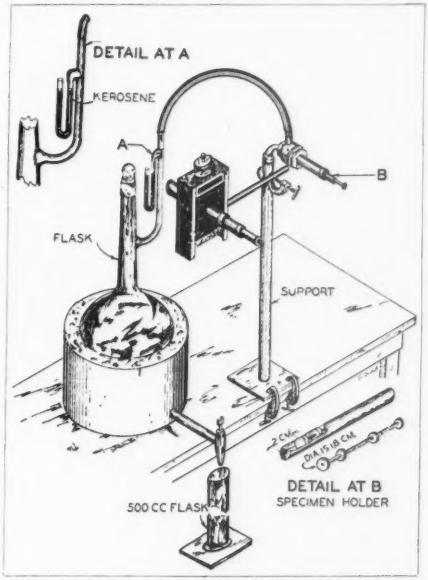


Fig. 1. Apparatus used to measure fineness of fibers.

duces a pressure change which, when it becomes constant, is read on the manometer using the micrometer and microscope. This change may be used as read for the convenience of smaller numbers or may be multiplied by two to include both arms of the manometer and all the pressure difference. By keeping both the weight of the specimens and the rate of flow of the mineral oil constant the only readings essential are those for pressure difference. If it is desired, the surface per gram of the fibers can be calculated as was done by Sullivan and Hertel. Such conversion should probably be made before making comparisons with results obtained in other laboratories unless apparatus and techniques are known to be identical. Where comparisons are needed between samples in only one laboratory such conversions are not essential.

Test Methods

To obtain satisfactory results certain precautions should be taken. All wads of cotton should be prepared and inserted in the cylinder in the same way as nearly as possible. The temperature of the laboratory should be held constant to maintain a constant rate of flow of oil or corrections made for variations. The oil in the flask should be kept at approximately the same level.

In this report 36 cottons, the fineness of which had been determined by the weight-per-inch method, were used. These ranged from a fine cotton weighing 2.69 mg. to a coarse cotton weighing 5.87 mg. per inch. These weights were the averages for three specimens of each cotton. From a sliver of carefully mixed and parallel fibers three wads of cotton, each weighing 250 mg., were prepared. Each was placed in the cylinder with the fibers parallel with the direction of air flow, and readings were taken of the change in pressure as the oil flowed from the flask. The average of the ten readings was considered the true reading of that wad and the average of the three wads the reading for that cotton.

Cotton Number	Weight Per Inch (μg.)	Pressure Difference (mm.)	Cotton Number	Weight Per Inch (μg.)	Pressure Difference (mm.)
1	4.06	2.57	19	4.55	2.01
2	5.65	1.59	20	4.67	2.08
3	3.98	2.38	21	4.71	1.87
4	5.37	1.81	22	4.79	1.91
5	5.58	1.91	23	4.96	1.84
6	5.49	1.89	24	4.45	2.54
7	2.69	3.25	25	4.53	2.46
8	4.49	1.98	26	4.55	2.55
9	5.33	1.89	27	3.17	2.96
10	5.16	1.80	28	4.89	1.99
11	4.66	2.10	29	5.72	1.66
12	5.46	1.68	30	4.51	2.18
13	3.24	3.02	31	4.95	1.76
14	3.74	2.87	32	4.06	2.50
15	4.07	2.62	33	4.20	2.40
16	4.20	2.51	34	3.48	3.26
17	4.23	2.32	35	3.77	3.04
18	4.35	2.04	36	5.87	1.56

TABLE I. Fineness of 36 cottons as measured by two methods.

The averages of the weight-per-inch and manometer readings are given in Table I in which it will be noticed that in general the finer the cotton the lower is the weight-per-inch but higher is the manometer reading.

The linear correlation coefficient between pressure difference and weight-per-inch of the 36 cottons is — 0.92 which seems satisfactorily high, particularly since the same fibers were not used in both methods and that there is often considerable difference between samples of the same cotton. The variation between samples was greater than that within a given sample. The relation between the two methods as shown for each cotton and the regression line are shown in Figure 2.

The results by the air permeability method can be converted to that of the weight-per-inch by the equation,

weight-per-inch =

7.8225 — 1.4608 times the pressure difference.

The conversion may be made also by reference to a large scale regression line or a conversion table.

The fineness was determined on four samples of each

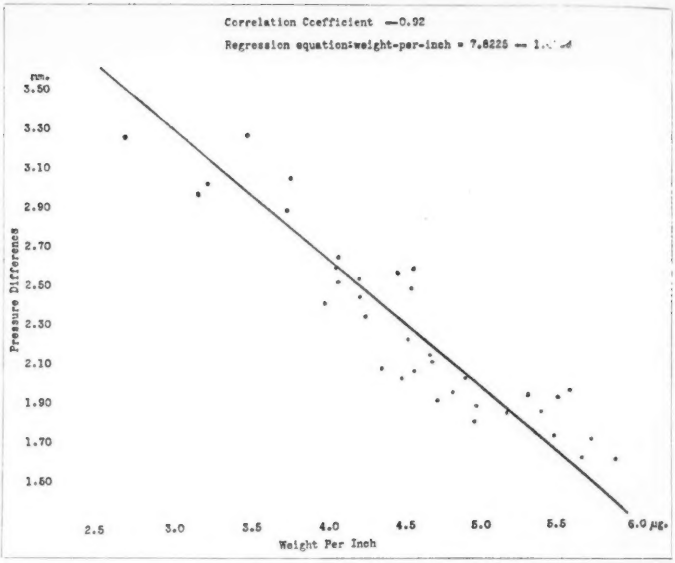


Fig. 2. Relation between weight-per-inch and pressure differences.

of five of these cottons by Sullivan (2), using the method developed by Sullivan and Hertel. Figure 3 shows graphically the relationship between all possible comparisons of the results by the three methods on these five cottons. These graphs show close agreement between the surface per gram and the pressure difference, between the weight-per-inch and pressure difference, and between the surface per gram and weight-per-inch, indicating that the three methods are of approximately equal accuracy as measurements of fineness.

There are a number of advantages of this newer method over the weight-per-inch method—less expensive equipment is necessary, much less time is required for learning the technique, and less time is used in making the determinations.

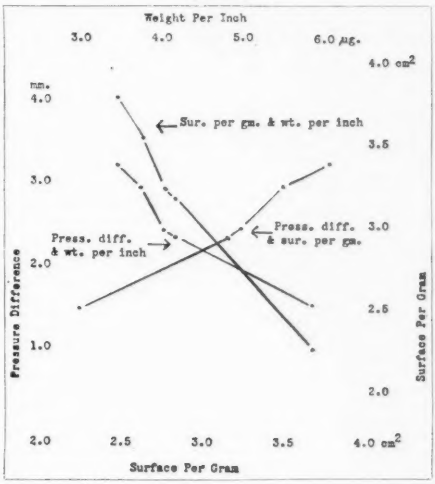
The apparatus used in this study can be made from equipment found in most physics or chemistry laboratories. A Torsion balance was used, but any balance

of the desired accuracy and capacity may be used. In the weight-per-inch method, balances of two capacities and an expensive sorter are necessary.

The training required for the method reported can be acquired in less than one hour in contrast with a minimum of one to two weeks necessary before satisfactory arrays and fineness determinations can be made by the weight-per-inch method.

The most important feature of the air permeability method is probably the great saving of time over the older method of making the determinations. A well mixed sample must be prepared for either method so the time required for preparation is equal. In the weight-per-inch method arrays are made and weighed, length determined, and lots of 100 fibers of each length group extracted and weighed, and calculations made for the fineness. An experienced operator can average approximately five arrays or six fineness determinations per day or make three arrays and three fineness determinations per day. If an average of three determinations is used for each cotton, only one cotton can be arrayed and the fineness determined in one day. The time required for arithmetic calculations is many times greater for the weight-per-inch method. Of course, when arrays are made other valuable information is also obtained, namely, the length and uni-

Fig. 3. Comparison of results of three methods of measuring fineness of cotton fibers.



formity of the fibers; however, even if this information is also desired the method for determining fineness as here reported would permit many times as many determinations per day, and frequently the fineness may be the only measurement desired for a particular cotton.

Method Permits Rapid Testing

In the proposed method, three wads of 250 mg. each can be taken from a well mixed sample and weighed in approximately five minutes. Allowing 15 minutes for insertion of the cotton and making ten readings of the manometer, the data for three wads of cotton can be completed in 20 minutes, or at most 30 minutes, making possible the fineness determination, including all calculations, of 16 to 24 cottons per eight-hour day. The time can be considerably shortened if one or two samples of each cotton are sufficient and if only five readings are made, and in many cases no doubt these numbers will be satisfactory. It is believed also that the time required to make the manometer readings can be shortened by changes in the apparatus, making it possible to return the oil to the flask more quickly.

This study shows that in comparison with the weight-per-inch method the air permeability method gives a satisfactory measurement of the fineness of cotton fibers, with less expensive equipment and saves much time in the training of the operator, collecting and calculating the data.

Acknowledgment

Thanks are due to the Cotton Fiber and Spinning laboratory of the Agricultural Marketing Administration for furnishing a portion of the weight-per-inch data and for the use of their laboratory.

References

1. Sullivan, R. R. and Hertel, K. L. 1940. Surface Per Gram of Cotton Fibres As a Measure Of Fibre Fineness.
2. Personal communication from R. R. Sullivan.

RESEARCH AIDS

Ultra-Violet Light*

Numerous practical applications are being developed for the use of ultra-violet rays and fluorescence in the industries, sciences and arts. The more important of these applications are presented in a new book by the authors of "Fluorescent Light and its Application," and "Fluorescent Chemicals and their Application."

The book mentions some applications to military uses, and to the fields of criminology and medical science, and discusses the use of ultra-violet radiation in microscopy, spectroscopy, and in chemistry. A list is given of many of the more important inorganic and organic substances with their test reactions.

* ULTRA-VIOLET LIGHT AND ITS APPLICATIONS—H. C. Drake and Jack De Ment. *Chemical Publishing Co., Inc., 234 King Street, Brooklyn, N. Y. 209 pp. $3.25.*

Research the Creator of Wealth*

"It is from the research laboratory that new wealth must arise, as has originated in the past the new wealth represented by the automobile industry, the radio industry, and the industries founded on the movies, the airplane, plastics, rayon and hundreds of other new products.

"In the last analysis, the true measure of worth of a research laboratory to a company is the increase in wholly owned wealth (increase in value of stocks less increase in bonded indebtedness). This increase is often huge even when no dividends are being paid at all. Witness the increase in stock value of airplane and radio companies.

"Another function of research is insurance against loss, the loss that frequently has led to bankruptcy through a competitor bringing out a new product.

"Many banks realize all this and frequently insist on a company maintaining a research department. Nev-

ertheless there should not be an uncontrolled expansion of research. There has sometimes been a tendency to follow the process unthinkingly by companies who had no excuse for a research laboratory."

These excerpts are from a new book entitled "Industrial Research." This little book outlines the need of research, what research is, its functions in an industrial organization and outlines the adaptation of research to the needs of the small company as well as the large organization. It is very readable and its main points are illustrated by many concrete examples drawn from industrial experience. It is a book that merits reading by every business and industrial executive.

* INDUSTRIAL RESEARCH—by F. Russell Bichowski, *Chemical Publishing Co., Inc., 234 King St., Brooklyn, N. Y. 126 pp. $3.25.*

Measurement of Color Differences*

The photoelectric cell is finding ever-widening usage in scientific apparatus. The present CIRCULAR describes the development and use of an "artificial eye for color measurement," which consists of a barrier-layer photocell and three selected spectral filters.

Photoelectric tristimulus measurements are well suited for comparisons of the colors of spectrally similar specimens. In commerce such measurements may prove to be useful: (1) in the day-to-day control of the colors of materials in production, (2) in obtaining compliance of materials with color-tolerance requirements, (3) in making modifications of color to produce matches, and (4) in the measurements of color changes accompanying fading. Some advantages are: small number of settings required for each sample, and simplicity and inexpensiveness of apparatus.

* PHOTOELECTRIC TRISTIMULUS COLORIMETRY WITH THREE FILTERS. Richard S. Hunter, *Circular C429 of the Nat. Bu. of Standards, Washington. 46 pp.*

Permanent Protection Against Damage by Moths and Alkali Obtained with

Chemically Modified Wool

By WALTON B. GEIGER, F. F. KOBAYASHI, AND MILTON HARRIS

Wools that moths cannot digest and that are several times as resistant to the action of alkalies and certain other damaging agencies can be obtained through a process developed by Research Associates of the Textile Foundation at the National Bureau of Standards. Neither the softness nor the strength of the wools is impaired by the process which consists of transforming the chemical linkages of the wool that involve sulfur to more stable ones. The well known sensitivity of wool to attack by moths and to damage by alkalies constitutes its greatest defect. Hence, improved resistance to such destructive agencies should prove of value in such common uses as clothing, blankets, carpets, and in certain industrial applications where it may be exposed to the action of harmful chemicals.

One of the greatest practical disadvantages of wool has been that it is only moderately stable to a number of chemical agents, especially those that primarily attack the disulfide group of the cystine of the wool. For example, the degradation of wool by alkalies (1), by oxidizing agents such as peroxide (2), or chlorine (3), or by reducing agents such as the bisulfites or dithionites (also termed hydrosulphites or hyposulphites) (4), has been shown to result in part at least from the breakdown

Figures in parentheses indicate literature references at the end of this paper.

of these groups. Damage to wool by light also involves the breakdown of disulfide groups (5). In addition, rupture of these groups seems to be involved when moths attack wool (6), and also is necessary before enzymes can digest it (7). Yet disulfide groups are of primary importance in maintaining the unusual mechanical properties of wool, particularly its elasticity (8), since they serve as cross-links between the peptide chains of the wool protein (9). For these reasons there would seem to be an obvious advantage in transforming the disulfide groups to more stable ones through a process not deleterious to the mechanical properties of the wool.

Recent work in this laboratory (9) has led to the development of a series of chemical reactions by which this can be done. By treating the wool with a solution of thioglycolic acid or other mercaptan at a pH below 7.0, a portion of its disulfide groups can be reduced to sulfhydryl groups without destroying its fibrous structure, and without detectable changes in other chemical linkages. This reaction may be represented as follows:

$$W-S-S-W+2HSCH_2COOH \rightarrow 2W-SH+\begin{matrix}S-CH_2COOH\\S-CH_2COOH\end{matrix} \quad (1)$$

where W represents the portions of the wool connected by the disulfide groups. By treating the reduced wool with an alkyl dihalide, the sulfur atoms can be linked through short hydrocarbon chains, and new cross-links that are much more stable than the disulfide groups are produced, as the following equation indicates:

$$2W-SH+(CH_2)_nX \rightarrow W-S-(CH_2)_n-S-W+2HX \quad (2)$$

where X represents a halogen atom.

Work already published (3) has demonstrated that wool containing cross-links of this sort possesses enhanced stability to alkali. Since then a greater variety of products has been prepared, and their stability to a wider variety of chemical reagents, and to moths, molds,

and enzymes, has been studied. In addition, a number of improvements in the process for preparing the modified wools have been made, and are described below.

A. Experimental Procedure

1. Materials

The yarn used in the present study was part of the lot used in earlier investigations reported from this laboratory (7, 9). This yarn was a four-ply worsted prepared from raw wool that had been previously extracted with Stoddard solvent and washed with water. The yarn was further purified by extraction with alcohol and with ether for 6 hours each in a modified Soxhlet apparatus, so constructed that neither hot solvent nor vapor could come in contact with the wool, and finally by washing with distilled water. The cloth used was a plain-woven worsted, of the type described in Commercial Standard CS65–36 (10).

2. Methods

a. Reduction. Wool can be reduced, not only with sodium thioglycolate, as in the earlier work (9), but also with other salts of this acid, with the free acid, or with other mercaptans. Comparison of the results obtained with a number of the salts of thioglycolic acid showed that the calcium salt offered unusual advantages, since the products had the best tactile properties, and possessed the greatest stability toward alkali of any studied.

The reduction was carried out by immersing the wool in a solution of calcium thioglycolate at 50° C. and at pH 5. Under these conditions reduction was complete in 2 hours, while 20 hours required for reduction by the older procedure. To reduce about one-sixth of the cystine, 50 ml of a 0.02 $\underline{N}$ solution of calcium thioglycolate was used per gram of wool. To reduce about one-half of the cystine, 20 ml of a 0.03 $\underline{N}$ solution was used per gram of wool. To obtain products in which

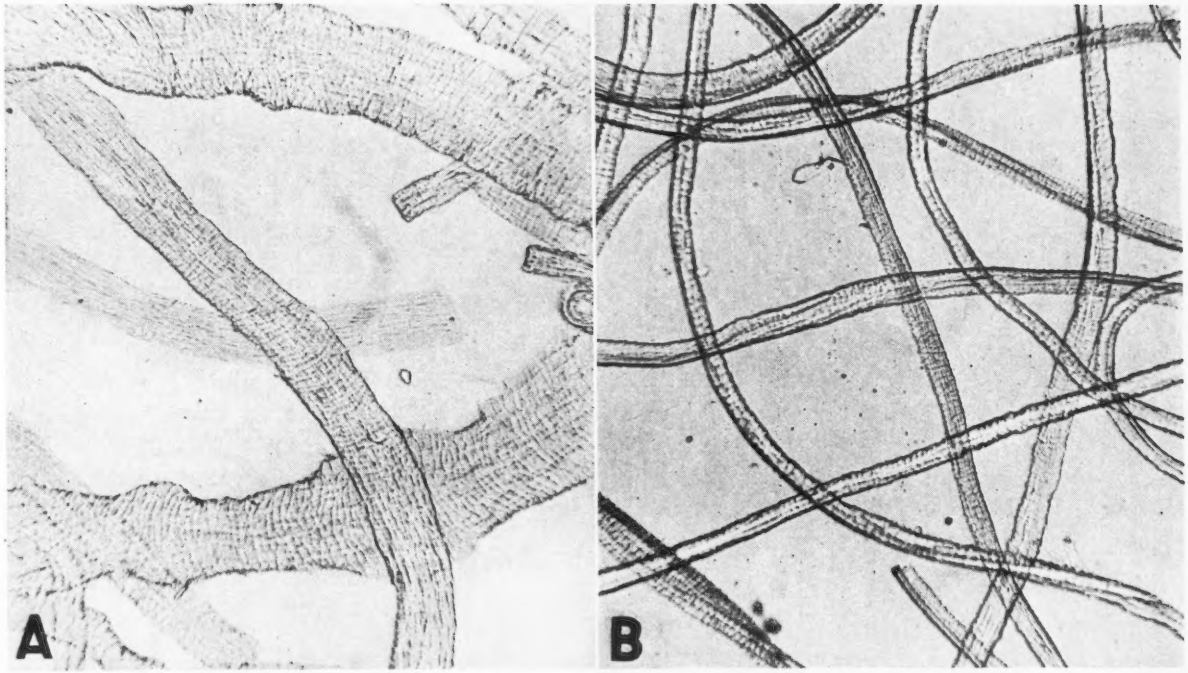


Fig. 1. Wool fibers after treatment for 30 minutes at 100° C. with 0.01 *N* NaOH. A, untreated wool. B, modified wool (cystine content 6.5 percent) prepared by reduction with calcium thioglycolate and alkylation with $(CH_2)_3Br_2$. Mag. × 150.

two-thirds of the cystine had been reduced, two applications of this latter reduction process was required. Products in which five-sixths of the cystine had been reduced were prepared by applying this reduction process four times. When successive reductions were used, each reduction was followed by alkylation.

b. Alkylation. Immediately after reduction, the wool was washed with water, then with 0.01 *N* phosphate buffer at pH 8.0, and again with water. The wool was then immersed in a 0.1 *M* solution of phosphate buffer at a pH value of 8.0 and 50° C., in which the alkylating agent had been suspended with the aid of a cationic wetting agent. About 0.0005 mol of the alkylating agent and 20 ml of the buffer were used for each gram of wool. The nitroprusside test given by the sulfhydryl groups of the reduced wool ordinarily became negative within 1 hour, but as a precaution the alkylations were continued for a total of 2 hours.

An investigation of the usefulness of a large group of organic dihalides as alkylating agents showed that they may be grouped roughly into three classes. The first class may be termed satisfactory reagents (those which react with reasonable rapidity and yield very stable products) including methylene bromide, trimethylene bromide, tetramethylene bromide, and 1,4-dichlorobutene-2. The second class consists of fair reagents (which react more slowly but yield satisfactory products) such as trimethylene chloride, triglycol dichloride, bis(2-chloroethoxy)methane. The third class includes unsatisfactory reagents, such as certain dihalides which are easily hydrolyzed, as benzal chloride and dichloroacetic acid, others with only one sufficiently reactive halogen atom, such as ethylene bromide, 1, 3-dibromopropanol-2, and 2, 2′-dichlorodiethel ether, and others that produce side reactions, such as styrene dibromide or 1, 3-dibromopropanol-2, which may act as oxidizing agents since the sulfhydryl groups are rapidly converted to the disulfide stage. The results described in this pa-

per are mainly those obtained with one of the best reagents, trimethylene bromide.

c. Analytical methods. The amount of unchanged cystine in the modified wools was determined by the method of Sullivan (11). The concentration of the solutions of thioglycolic acid was measured by titrating a sample with a 0.05 *N* solution of iodine, using starch as an indicator. Sulfur analyses were made by the oxygen-bomb method (12). The alkali-solubility was determined by the method of Smith and Harris (2) and represents by the method of the percentage of wool dissolved in 1 hour by 100 times its weight of a 0.1 *N* solution of sodium hydroxide at 65° C.

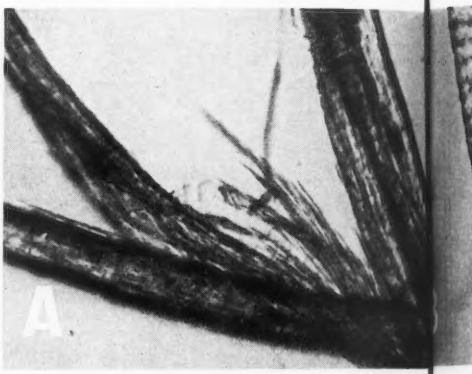


Fig. 2. Wool fibers after treatment with pe wool (cystine content 6.5%) prepared by redu with $(CH_2)_3Br_2$. Mag. × 150.

The breaking strengths of the samples of cloth were determined by the raveled-strip method (10) in the warp direction, with a pendulum-type machine and each value represents the average of at least 10 measurements. The reflectances of the samples of cloth were measured by the method of Reimann and Mease (13).

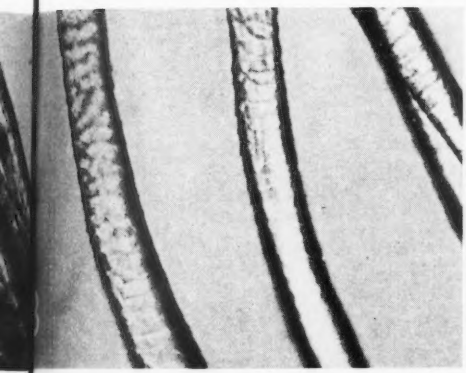
B. Results and Discussion

1. Resistance to alkali

Wool comes in contact with alkali in processes like laundering and scouring. The action of alkali may diminish the strength and durability of the wool, cause it to turn yellow, and impair its tactile properties, rendering it harsh. Since the linkages of wool protein

most susceptible to disruption by alkali are the disulfide groups, transforming them to the more stable *bis*-thioether groups should increase the stability of the wool to alkali. The effect of boiling with dilute alkali upon untreated wool and upon a modified wool is illustrated by photomicrographs of fibers in figure 1. It is apparent that the fibers of the untreated wool show far more swelling and disruption than do the fibers of modified wool.

Three other tests for resistance toward alkali were also used: (1) alkali solubility, (2) the extent of yellowing of the products by alkali, and (3) the effect of alkali on the breaking strength of strips of cloth. The alkali-solubilities given in table I show that the modified wools have a decidedly greater resistance than does untreated wool. Closer examination of these data also shows that, although the resistance to alkali increased as the cystine content decreased, little advantage was gained by diminishing the cystine content below 6 percent. Treatment with boiling solutions of sodium carbonate, which rapidly turns untreated wool yellow, has considerably less effect upon the modified wools, as the reflectance data of table I indicate. The loss in reflectance upon treatment with alkali became less as the content of unchanged cystine was diminished. The effect of treatment with boiling solutions of sodium carbonate upon the breaking strengths of strips of wool



th pe 1 weeks (7). A, untreated wool, B, modified redu calcium thioglycolate followed by alkylation

cloth is also reported in table I. The loss in breaking strength of the chemically-modified wools upon treatment with sodium carbonate was somewhat less than that of the untreated wool.

TABLE I. Action of alkalies upon untreated wool and upon modified wools prepared by reduction followed by alkylation with $(CH_2)_3Br_2$. Alkali-solubility of the wools, and their reflectance and breaking strength after boiling for 1 hr. with 0.02 *N* sodium carbonate.

Cystine	Alkali-solubility	Reflectance [a]	Breaking strength [b] Before treatment with Na_2CO_3	Breaking strength [b] After treatment with Na_2CO_3
percent	percent	percent	kg	kg
		(A) Untreated		
12.2	10.0	37.8	14.0	10.0
		(B) Modified		
10.0	6.2	37.6	13.5	11.5
6.5	2.9	41.0	13.5	12.0
4.0	2.5	46.5	12.5	12.0
2.0	2.0	47.5	12.5	11.5

[a] With respect to magnesium oxide.
[b] Strips 2.54 cm wide, 49 ends.

2. Resistance to acids

Not only do the modified wools show improved stability to alkali alone, but they also show greater stability to alkali after being treated with acids. Improved stability to such a succession of treatments is important because degradation which may occur when wool is carbonized, acid-dyed, or acid-fulled may be greatly accentuated when the material later comes in contact with alkali, as in laundering. Table II illustrates typical results. Because the amounts of soluble nitrogenous materials, which represent partly hydrolyzed protein frag-

ments, that result from each acid treatment are similar for the untreated and the modified wools, it seems likely that about as many peptide chains are hydrolyzed by the acid in one material as in the other, since there is no *a priori* reason for peptide bonds to be stabilized by reaction involving only the sulfur. The hydrolytic ac-

TABLE II. Action of acids upon untreated wool, and upon modified wool (cystine content 6.5 percent) prepared by reduction followed by alkylation with $(CH_2)_3Br_2$.

Conditions	Alkali-solubility before treatment	Alkali-solubility after treatment	N liberated in percent of Total N
Untreated HCl, 0.1*N*, 65°C, 24 hrs.	9.5	20.0	2.0
Modified " " " "	2.5	6.3	1.7
Untreated HCl, 0.1*N*, 65°C, 10 days	9.5	80.0	11.8
Modified " " " "	2.5	45.0	11.3
Untreated H_2SO_4, 0.1*N*, 65°C, 24 hrs.	9.5	28.8	2.9
Modified " " " "	2.5	9.9	2.5

tion of a given acid treatment should therefore result in about the same decrease in average molecular weight for each material. The subsequent alkali-solubility test involves breakdown of the disulfide groups of the unmodified wool but not of the *bis*-thioether groups of the modified wool. For these reasons the greater alkali-solubility of the unmodified wool appears to depend on a decrease in molecular weight that results from the rupture both of disulfide cross-links and of peptide bonds.

The carbonizing of wool with sulfuric acid differs from the above treatments in involving baking at a high temperature (about 125° C.). The results obtained on

subjecting untreated and modified wools to a typical commercial carbonizing process are recorded in table III. The untreated wool, after carbonizing had a high alkali-

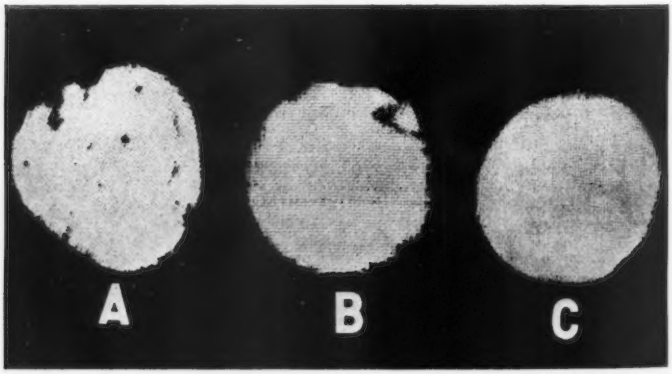
TABLE III. Effect of carbonizing with sulfuric acid upon untreated and upon modified wool (cystine content 6.5 percent) prepared by reduction followed by alkylation with $(CH_2)_3Br_2$.

	Alkali-solubility		Breaking strength *	
	before carbonizing	after carbonizing	before carbonizing	after carbonizing
	Percent	Percent	Kg	Kg
Untreated	9.5	19.4	13.5	13.5
Modified	3.5	11.0	13.0	13.0

* 2.54 cm strips, 49 ends.

solubility, so damage might easily result from laundering or other treatments involving alkali. The alkali-solubility of the modified wool after carbonizing had increased too, but the final value was much lower.

Fig. 3. Wool samples after subjection to moth larvae. Untreated wool, A; modified wools prepared by reduction with calcium thioglycolate followed by alkylation with $(CH_2)_3Br_2$: B, 10.0% cystine, C, 6.5% cystine.



3. Resistance to reducing agents

Wool is often subjected to the action of reducing agents. For example, wool papermakers' felts frequently come in contact with sulfites. Reducing agents, including dithionites are also used in dyeing wool with indigoid colors. Such reducing agents tend to make wool extremely susceptible to the action of alkali (4). Reducing agents appear to attack wool mainly by breaking the disulfide linkages of the cystine. Sodium bisulfite, for example, probably reacts as follows (14):

$$W-S-S-W+N_aHSO_3 \rightarrow W-S-SO_3Na+W-SH$$

The ionized thiosulfate and mercaptan groups formed by this reaction would be expected to increase the alkali-solubility of the wool. The *bis*-thioether linkages of the modified wools cannot, however, react in this way, so such wools should be far more stable to reducing agents. The results obtained by determining the alkali-solubility of both unmodified and modified wools which since have been treated with reducing agents are recorded in table IV. The modified wool was found in every case to be considerably less affected by the reducing treatment than was untreated wool. (Continued on page 32)

TABLE IV. The action of reducing agents upon untreated wool, and upon modified wool (cystine content 6.5 percent) prepared by reduction followed by alkylation with $(CH_2)_3Br_2$. For each gram of wool, 100 ml of the indicated reagent was used.

Reagent	Conditions			Alkali-solubility	
				Untreated	Modified
				percent	percent
None				10.0	2.5
$NaHSO_3$	1%	100°C	1 hr.	15.2	4.8
$Na_2S_2O_4$	10%	50°C	2 hrs.	39.0	4.5
$Na_2SO_2-CH_2O$	5%	50°C	2 hrs.	13.3	3.7
NaSH	0.2*N*	50°C	2 hrs.	41.5	3.2

4. Resistance to oxidizing agents

Wool comes in contact with oxidizing agents during bleaching with peroxide, during treatment with chlorine, and also in use, through the action of light and air. The effect upon wool of certain chemical oxidizing agents is recorded in table V, where alkali-solubility is again used

TABLE V. The action of oxidizing agents upon untreated wool, and upon modified wool (cystine content 6.5 percent) prepared by reduction followed by alkylation with $(CH_2)_3Br_2$. For each gram of wool, 100 ml of the indicated reagent was used.

Reagent	Conditions	Alkali Solubility	
		Untreated	Modified
		percent	percent
None		10.0	2.5
Cl_2	0.01*N*, 100°C, 1 hr.	13.6	6.6
H_2O_2	2 vol., 50°C, 1 hr.	15.5	4.0
$KMnO_4$	1%, 35°C, 1 min.	17.5	10.4
$K_2Cr_2O_7$	0.2%, 100°C, 1 hr.	11.0	4.6

as a criterion of damage by the oxidizing agents. The results show that the transformation of disulfide groupings to *bis*-thioether groupings diminishes the deleterious effects of oxidizing agents, since although the alkali-solubilities of both the modified and the untreated wool have increased, those of the modified wools remain low enough to indicate considerable resistance.

5. Resistance to staining by heavy metals

Wool is easily stained by contact with metals, as by the metal fasteners sometimes used with wool clothing. This staining may possibly result either directly from the reaction of the wool with the metal or from the reaction with oxides or salts formed on the surface of the metal. It was found qualitatively that the extent of staining by solutions of certain salts of iron, silver,

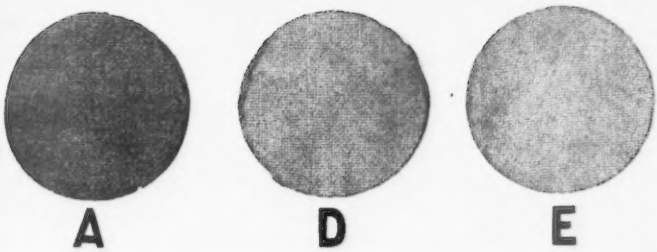


Fig. 4. Wool fibers after treatment for 30 minutes at 100° C. with 0.02 *N* lead acetate, pH 5.0. Untreated wool, A; modified wools prepared by reduction with calcium thioglycolate and alkylation with $(CH_2)Br_2$: D, 4.0% cystine, E, 2.0% cystine.

copper, and lead was considerably greater with untreated wool than with certain of the modified wools. The results obtained by staining with lead acetate are illustrated in figure 4. The modified wools were stained very much less by a solution of lead acetate than was untreated wool, and the extent of staining decreased as the amount of unchanged cystine decreased. Most of the modified wools studied were similar in this respect, but wool prepared by reduction followed by alkylation with methylene bromide, a process that converts its cystine to djenkolic acid (which contains $-S-CH_2-S-$ linkages), was found to be exceptional, since it was stained by lead acetate almost as readily as untreated wool.

6. Resistance to enzymes, moths, and carpet beetles

Proteolytic enzymes digest untreated wool extensively only after a portion of the disulfide bonds have been broken, although less complete digestion takes place after mechanical injury or after contact with dilute acid for several days (7). The wools containing *bis*-thioether cross-linkages showed greatly enhanced resistance to digestion, and were not attacked by pepsin even after mechanical injury, or after treatments with acid sufficient to render untreated wool readily digestible. Pho-

tomicrographs illustrating the experimental results are shown in figure 2.

Moth larvae, according to Linderstrøm-Lang (6), can digest wool only after breaking its disulfide cross-linkages by the action of a reducing agent present in their intestinal tracts. For this reason it seemed probable that the modified wools containing *bis*-thioether linkages would be far more stable to biological agents than untreated wool, and such stability was actually observed. The new linkages probably interfere with the preliminary reductive step, since *bis*-thioether linkages, as shown above, are very resistant to the action of reducing agents.

TABLE VI. Action of moth larvae upon untreated and upon chemically modified wools prepared by reduction followed by alkylation with $(CH_2)_3Br_2$. Ten larvae were used for each sample.

Cystine content	Loss in weight
percent	percent
(A) Untreated	
12.2	15.5
(B) Modified	
10.0	8.0
6.5	0.3
4.0	2.9
2.0	0.1

A study of the ability of the new cross-linkages to minimize the extent of attack by moths has shown that the modified wools are attacked to a considerably less extent than is untreated wool, and that the resistance increases as the content of unchanged cystine decreases. Table VI indicates results obtained when wool samples were subjected to the action of moth larvae, and photographs of the actual samples are shown in figure 3.[3] The

[3] We wish to thank John A. Levering and J. W. Creely of the Eavenson & Levering Company, Camden, N. J., for the tests with moth larvae, and A. G. Ashcroft and R. C. Allison of Alexander Smith & Sons Carpet Company, Yonkers, N. Y., for the tests with carpet beetles.

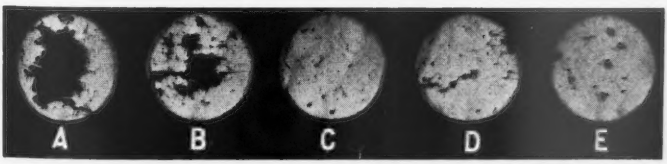
modified materials having cystine contents of 6 percent or less were only slightly attacked, and this attack was mainly around the edges, while numerous holes were eaten into the untreated samples. It also appears that reducing the cystine content to 6 percent provides about as much protection as the more extensive treatments. It should be pointed out that the mothproofness produced by the present method is not removed by laundering or dry-cleaning, since it is "built into" the molecule as an integral part of its chemical structure.

TABLE VII. Action of larvae of the black carpet beetle upon untreated and upon modified wools prepared by reduction followed by alkylation with $(CH_2)_3Br_2$. Each sample was exposed to ten larvae for 30 days.

Cystine content	Wt. of excrement
percent	mg
(A) Untreated	
12.2	52
(B) Modified	
10.0	45
6.5	21
4.0	34
2.0	23

Carpet beetles were found to damage both the untreated and the modified wools more extensively than

Fig. 5. Wool samples after subjection to the larvae of black carpet beetles (*Attagenus piceus*). Untreated wool, A; modified wools prepared by reduction with calcium thioglycolate followed by alkylation with $(CH_2)_3Br_2$: B, 10.0% cystine, C, 6.5% cystine, D, 4.0% cystine, E, 2.0% cystine.



did moth larvae, as the data of table VII, and the photographs of figure 5 illustrate. Nevertheless, the modified wools were decidedly more resistant than untreated wool to such attack.

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RESEARCH BRIEFS

Measurement of Wool Fiber Length

A New Technique for the Analysis of Fiber Length Distribution in Wool. H. E. Daniels, *Jour. Text. Inst.*, Vol. 33, No. 8, Aug. 1942—p. T137–T150.

A new sampling technique is offered that is applicable not only to the measurement of tops but to card sliver, woolen slubbing and wool in web form and yields a sample of the draw, or "true" sample type. A brief description of the two principal methods now in use is given together with the disadvantages of each. In this new method the top, instead of being broken, is cut. Then, once the cut fibers are removed, the end of the top is in the correct state for the extraction of the sample draw. In this method measurements are taken of individual fibers in the sample. The time consumed is much less than would at first be imagined and the method has proved a thoroughly practical one.

Hydrolysis of Proteins

Catalyzed Hydrolysis of Amide and Peptide Bonds in Proteins. Jacinto Steinhardt and Charles Fugitt. *Jour. of Resch.*, Nov. 1942.

Research Associates of the Textile Foundation at Nat. Bu. of Standards have discovered that in the presence of certain dyes and ions derived from acids of high molecular weights, proteins are hydrolyzed at 65° C. over 100 times as fast as when they are hydrolyzed by dilute solutions of hydrochloric acid alone. Two proteins, purified wool and crystallized egg albumen were hydrolyzed in the experiments. The rates of hydrolysis depend not only on temperature and acidity but vary according to the type of acid used. These differences in effectiveness are attributed to a catalytic action of

the anions of these acids, on the basis of experiments in which the concentration of the anions is varied independently of the concentration of acid. The catalytic action of the effective ions is suggestively similar to the action of enzymes in digesting proteins. The experiments show that the catalytic effect depends on the ability of the ions to combine with groups near the bonds that are attacked. This demonstration is used as a basis of proposing a theoretical mechanism of the acid digestion of proteins. The selective action of low concentrations of the catalysts may be useful in analysis, or in the production of modified proteins. The milder treatment should lead to less destruction of the less stable amino-acids essential to normal nutrition.

Influence of Structure on Synthetic Fibers

INTERNAL STRUCTURE OF SYNTHETIC FIBERS AND ITS INFLUENCE ON THEIR PHYSICAL PROPERTIES. E. H. Freund and H. Mark. *Rayon Tex. Monthly,* Sept. 1942—p. 59(515)–61(517); and Oct. 1942—p. 57(605)–58(606).

After the tensile strength has once reached a numerical value, there are other properties of a fiber such as recovery, flexibility, setting properties, durability, and dyeing to be considered. This paper describes the fundamental properties of the unorganized, crystalline areas, and points out in a few examples how they affect these properties. All samples of a synthetic and presumably also natural high polymers are sensitive to changes in humidity, temperature, presence of swelling agents, etc. From the point of view of thermal properties, rubber is one of the best investigated high polymers. Description is given of the reaction of rubber under different treatments. A comprehensive bibliography is included of the subject of fiber structure, its reactions and behavior.

Cotton Fiber Structure, Properties and Use

STRUCTURE, PROPERTIES, AND UTILIZATION OF COTTON. R. F. Nickerson, Mellon Institute. *Ind. and Eng. Chem., Ind. Ed.,* Oct. 1942—p. 1149–1153.

Domestic cotton might, through modification or more efficient utilization, become adequate in wider applications. The purpose of the paper is to present facts and concepts that might assist the cotton technologist. A summary of the constitution, structure, properties, and especially the behavior of cotton under external agencies, is presented to facilitate possible changeovers. The effects of moisture, heat, stresses, and time on fiber properties, particularly from the point of view of hydrogen bonding and the amorphous fiber component are given in detail. Also a few examples of industrial applications are cited by way of illustration.

Evaluating Physical Properties of Fabrics

PHYSICAL METHODS FOR EVALUATING THE HAND OF FABRICS AND FOR DETERMINING THE EFFECTS OF CERTAIN TEXTILE FINISHING PROCESSES. Edwin C. Dreby, *Am. Dye. Rep.,* Oct. 12, 1942—p. 497–504.

There are at least eight physical properties of cloth which affect the judgment of hand. The problem of evaluating these properties is not a simple one. Detailed description together with an outline of their several applications is given of three instruments: the Planoflex for measuring flexibility; the Friction-Meter for measuring surface friction; and the Compression-Meter for measuring compressibility of fabrics. Studies were made of eighteen 80 × 80 cotton percales. The observations indicate the reliability, sensitivity, and significance of the results obtained with these instruments which are sensitive to small differences in finish. Tables show comparisons of the ratings obtained and the results

of tactual and instrumental evaluation.

The Effect of Resin Finishes

THE EFFECT OF RESIN FINISHES ON THE COLORFASTNESS AND PHYSICAL PROPERTIES OF RAYON GABARDINES. Hazel M. Fletcher, Wilda Marguerite Hay and Andrea Jean Surratt. *Am. Dye. Rep.*, Oct. 12, 1942—p. 489–493 and p. 514.

The resin finished fabrics had a firmer handle than the non-resin finished and had a better appearance after cleaning. Dry cleaning had little effect, but both were somewhat changed by laundering. The non-resin finished gabardines became sleazy on laundering and some of them showed considerable yarn slippage after abrasion. The statistical analysis of the data showed significant differences in the colorfastness and the physical properties, favoring the resin finished over non-resin finished gabardines. The resin finished gabardines were definitely stronger, the shrinkage in laundering was less, and the elongation under test significantly less than the non-resin finished.

Vat Dyeing of Viscose Rayons

VAT DYEING OF VISCOSE RAYONS. Arthur R. Wachter. American Viscose Corp., 350 Fifth Ave., New York. 7 page report.

The demand for serviceable colors for garments made from spun viscose rayon as well as mixtures with wool or cotton, can best be met with vat colors because of their excellence to light and good fastness to laundering and perspiration. This paper condenses the more important needed information, gives some detailed information in regard to laboratory control, and gives a method for overcoming a shade difference from one end of roll to other on vat-pigment-pad-jig dyeing. Details are given of a pigment pad-jig method for rayon.